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## THE PRODUCTION OF SOUND BY LIGHT.

THE paper of Professor Bell, on "The Production and Reproduction of Sound by Light," seems to have created considerable excitement in the scientific world generally. Should the results of his experiments prove to be well founded, a distinct step in advance will have been made in the progress of science, and this step will have been a most important one, and one reflecting the very highest credit upon the discoverer. The experiments made with selenium do not, we think, admit of any question as to their accuracy, but we must confess that we are sceptical as to the conclusions drawn by Professor Bell from the results of his experiments upon the apparent transmission of sound by the direct action of light. Considering that the supposed discovery quite throws into the shade the experiments made with selenium, since the latter, although the successful results of careful and patient experiment, were to a great extent foregone conclusions, it is difficult to understand why the alleged discovery occupied so comparatively a small space in Professor Bell's paper; unless, indeed, the author were himself not completely satisfied of the soundness of his inferences.

It is possible that Professor Bell may have made more numerous experiments than those described by him in his paper, but certainly those detailed are hardly conclusive on the point, that the observed phenomena were due to the action of light rays alone. We shall await with great interest further details of Professor Bell's experiments, and while giving him the very highest credit for the discoveries made, we must at the same time remain doubtful of the accuracy of all the conclusions drawn.

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THE question as to what system is to be adopted for lighting the City thoroughfares by electricity is not yet settled. The authorities have viewed that of Jablochkoff, on the Thames Embankment; that of Brush, at Liverpool Street; and, we believe, the Crompton light, at the Alexandra Palace. Others have yet to be inspected, amongst them that of Messrs. Siemens Brothers. The decision will probably not be arrived at before the Board meeting of October 19.

## THE PHOTOPHONE.

AT a recent meeting of the American Association for the Advancement of Science, an important paper was read by Professor Graham Bell. The paper was entitled, "The Production and Reproduction of Sound by Light." It was shown how clear articulate sounds could be obtained by means of a pencil of light directed upon a selenium "cell," this cell being in local metallic circuit with a battery and telephone. At the commencement of the lecture Professor Bell enumerated those persons by whose researches he had profited, including Mr. Willoughby Smith and Lieut. Sale, R.E., whose papers upon the subject of the action of light upon the electrical resistance of selenium were read before the Society of Telegraph Engineers.

It was stated that nearly all other substances possessed the property of being affected by light, but in a lesser degree, and that results had been obtained with gold, silver, platinum, brass, zinc, copper, ebonite, ivory, paper, &c., the exceptions being, as far as ascertained, carbon and glass. Carbon, it is supposed, was not acted upon in consequence of the thickness of the piece tried; but glass, if silvered, gave excellent results, and it was inferred that its transparency in the first instance prevented any effects being produced.

Professor Bell also spoke of Mr. Willoughby Smith's attempts at making resistances out of selenium, and he pointed out that some of the alloptric forms of the substance were insulating, whilst the granular or crystalline forms conducted comparatively freely.

In endeavouring to effect the object which was the subject of the paper, it was found that the lowest resistance hitherto obtained with selenium was altogether too high for the purpose, and after several experiments a "cell" was constructed, the resistance of which was only 300 ohms in the dark, and 150 ohms in the light. After explaining the form of resistance devised by Dr. Siemens, which consisted of a drop of selenium flattened between two small mica discs, a sort of gridiron of wires formed in two distinct sets being inclosed in the mass of the substance, Professor Bell explained the construction of a "cell" devised by himself. It consists of a number of brass discs, about 2 inches in diameter, separated from each other by thin sheets of mica, the mica discs being a little smaller than the brass ones, so that when the cylinder (which is about 2½" in length) is built up there will be minute interstices between the edges of the brass discs. These are filled in with selenium. Brass discs were preferred for the following reason: with other metals selenium acted like water upon oil, but upon brass it has a chemical effect which seemed to facilitate the construction by its entering into a good connection with the metal. When the brass discs were built up and clamped together they were heated until they reach a suitable temperature (about 214°), when a stick of selenium was rubbed over the edges, filling the interstices, and afterwards it was annealed, so as to render the selenium crystalline. It was explained that the annealing was a very simple matter; all that was necessary was to heat it gently until the surface became dull, just as

a mirror would if breathed upon; when that occurs it has reached its proper temper. In fact, it is safe to continue the heat a little longer, until the substance just begins to fuse, and then immediately stop the heat and set it to cool; when this has taken place the substance will be crystalline in character, and its resistance at its lowest.

The "cell" thus formed is set in the focus of a parabolic mirror.

Several ingenious plans were devised for enabling the cell to act as a medium for the transmission of sounds. For articulate speech the light rays must be undulatory. For sonorous vibrations producing musical notes a revolving disc, having holes pierced all round a short distance from the outer edge, was used.

The first form of transmitter consisted of a pair of gratings, one being fixed and the other movable and attached to a diaphragm and a mouthpiece, the movable grating being placed in front of the fixed one; a greater or less amount of light would then pass through the openings according as the bars and slits in each corresponded in position more or less, and as they were regulated in position by the vibrations of the diaphragm fixed to the grating. Behind the gratings the selenium cell was fixed, which was thus acted upon more or less by the light.

Another form of cell consisted of a square vessel with the two opposite sides of glass and a diaphragm at the bottom. It was filled with water or other suitable liquid. In the normal condition the glasses are plane, and the light passes through unaffected; but the vibrations communicated to the diaphragm give a motion to the liquid which renders the glasses convex and concave alternately, and consequently varies the effect of the light in passing. Professor Bell stated that this had recently been invented by a Frenchman, Dr. Cusco.

The simplest transmitter of all consists of a mouthpiece and diaphragm only, the diaphragm being of *silvered* microscopic *glass;* against the back of this mirror the speaker's voice is directed. The light reflected from the mirror is thus thrown into vibrations corresponding to those of the diaphragm itself.

With all these transmitters the selenium cell is placed in circuit with a telephone and a battery, and the action of the light on the cell, as modified by the action of the transmitter, by varying the current produced distinct sounds on the telephone.

With the revolving disc sending intermittent rays of light on the cell the effect was powerful. When the cell was shielded with a thin piece of "hard rubber" or ebonite, the sounds were still audible. The experiment was afterwards made of placing the piece of rubber close to the ear, and allow the intermittent light to fall on it; sounds were distinctly heard. Better effects are produced by arranging the rubber as a diaphragm and listening through a hearing tube. The diaphragm was varied, and various metals tried; antimony gave the best effect. Carbon and glass, as at first pointed out, gave no effect unless the glass was silvered. A thin disc of selenium also gave an effect, but not an intense one. Rubber was the most effective of all the materials tried.

In connection with Professor Bell's discoveries, Professor Minchin's paper will be read with interest, bearing as it does upon the subject of the connection between light and electricity.

We may mention that some months ago we witnessed some experiments by Mr. W. H. Preece, exactly similar to those carried out successfully by Professor Bell. A Siemens selenium cell was placed in the circuit of a battery and telephone, the cell being placed in a light-tight box provided with an opening opposite the cell. A revolving disc with openings was placed opposite the aperture in the box, so that light could be alternately cut off and allowed to fall on the cell with any degree of rapidity. It was anticipated that a musical note would be produced on the telephone, but no such effect could be perceived; the experiment doubtless failed in consequence of the high resistance of the selenium cell. Pressure of work prevented Mr. Preece from continuing the experiments which so nearly anticipated Professor Bell's announcements.

The subject was also discussed at the recent meeting of the British Association at Swansea, after the reading of Professor Minchin's paper on photo-electricity.

## AN ACCOUNT OF EXPERIMENTS IN PHOTO-ELECTRICITY.

By G. M. MINCHIN, M.A., Professor of Applied Mathematics in the Royal Indian Engineering College, Cooper's Hill.

(Read before the British Association, Aug. 1880.)

(*Continued from page* 312.)

13. FLUORESCENCE.—In a fluorescent body the energy of certain rays is absorbed, and then given out as a radiation composed of rays less refrangible than those which the body has received. There seemed *à priori* to be reason for supposing that the transformation of energy which takes place by means of fluorescence might, under favourable circumstances, show itself by the generation of electrical current out of the energy of the incident rays. Hence I determined to try whether, if light fell on a plate coated with a fluorescent substance, a current would be generated, the other details being arranged, as in the experiments already described, with emulsions of silver salts.

This is, at present, an unverified theory; for, although strong currents are obtained from some fluorescent substances, it is probable that chemical action (due, however, to the action of light) has more to do with these currents than fluorescent transformation.

14. EOSINE.—If a very small quantity of eosine is shaken up in a test-tube with a little distilled water, and liquid gelatine then poured into the tube and thoroughly shaken up with the eosine, we obtain a beautifully-coloured emulsion of eosine with which to coat a metallic plate.

The plates which I had been previously using (with silver salts) were silver; and, in endeavouring to prove the above theory of fluorescence, these were also the plates employed.

A silver plate was sensitised, with the eosine emulsion, and, when the film had sufficiently set, this plate was immersed in presence of another in a cell containing common tap water, and the circuit completed with a galvanometer. When magnesium light was allowed to

fall on S., a violent current was set up, whose direction was

*from U. to S. in the cell,*

*i.e.*, in the same direction as that given by AgCl and AgBr.

There was, of course, the usual D. C., the time of whose disappearance varied in different experiments from a few minutes to some hours.

The currents are strengthened by allowing the film to set thoroughly, so as to attain an intimate contact with the silver plate. This may be done by keeping the plate in a dry place for a day, or several days.

As usual, the effect of the rays at the blue end of the spectrum on this plate is greatest, and that of the red rays least; and I believe that in every experiment the currents produced by the different rays were all in the same direction.

An eosine plate prepared in this way has one serious drawback—viz., the readiness with which the eosine leaves the film and comes into the water.

Several attempts have been made to remedy this defect, but none have been completely successful. The best result has been obtained by pouring a layer of pure collodion over the eosine film when the latter has thoroughly set on the plate.

A plate coated in this latter way is exceedingly sensitive to sunlight. When placed in a glass cell at the top of the house, and connected in circuit with a galvanometer in a lower room, the faintest possible variation in the intensity of the light was recorded by a corresponding motion of the spot on the screen. Not only did the interposition of coloured glasses give variations of the current, but even the rapid passage of the hand in front of the cell produced backward and forward motions of the spot.

A numerical idea of the motions in question may be given by the fact that, if the equilibrium position of the spot is made to coincide with one end of the scale, sunlight falling directly on the plate will readily and rapidly drive the spot off beyond the other end.

The direction of the current generated by light is independent of any other current passing through the cell. On one occasion, when the cell was exposed to sunlight at the top of the house, and a commutator, placed on the window sill, had been used to complete connections with the galvanometer, the D. C. produced a motion of the spot to the left of the scale, while sunlight sent the spot off in the opposite direction. The connections were maintained during the remainder of the day and through the following night. Next day there was a very strong constant D. C. in the direction opposite to its previous direction. The cause of this, however, was the fact that rain had fallen and wet some solderings in the commutator, and the E. M. F. thus generated produced a strong current. Sunlight falling on the plate continued, nevertheless, to give strong currents in the same direction as before.

15. PHOTOGRAPHIC ACTION OF EOSINE CURRENT.—The current produced in this cell by sunlight was employed to produce the photographic decomposition of a bromide plate in the same manner as the current of the bichromate cell had been (Art. 11).

Two silver plates, each coated with Liverpool Emulsion, were immersed in a cell containing distilled water, with a few grains of KBr; the cell was placed in a dark box, kept in a lower room, and connected with the eosine cell on the top of the house. The sunlight at work on the eosine plate was exceedingly dull, so that it was allowed to act for about twenty hours (night included). The two bromide plates were then taken out and developed, with the results already described in Art. 11. These plates had not received a preliminary exposure to gaslight.

Two disturbing causes at present interfere with the employment of a plate thus prepared for the purpose of continuous registration of the intensity of sunlight. One of these is the weakening of the plate by the displacement of the eosine, and the other is the fact that, *on the withdrawal of the light, the spot does not at once go back to its zero position.* In some experiments the return to the zero position on the withdrawal of the light was made with satisfactory rapidity; but, especially if the action of the light had been continued for some hours, irregular motions of the spot to the right and left of the zero position, and through a considerable range of the scale, took place after the light was shut off.

For the purpose of a photometer, we must, of course, be certain that *the whole of the deflection existing at any instant is due to the intensity of the light shining at that instant*, and that if this light is suddenly removed, the deflection will cease.

16. ACTION OF LIGHT ON COLLODION.—The irregularity last mentioned suggested the propriety of covering silver and platinum plates with collodion and exposing them to the action of light.

A silver plate coated with pure collodion was placed in a cell, with tap water, in presence of an uncoated silver plate, and connected with the galvanometer. This cell was placed in the dark at the top of the house. There was on completing the circuit a D. C. from U. to S. in the cell. The cell was kept in the dark all night and most of next day. Then the D. C. had fallen so that the spot came back to 50 divisions of the scale from zero. Rather dull sunlight falling on S. gave a motion of the spot from 50 up to 150 or 200 divisions, in the same direction as that of the D. C. Variations of the current took place with those of light. When the cell was again covered up, the spot stood at a deflection of 150, instead of going completely back.

This cell (left connected all night) was used again next day. The spot started from a deflection of 40 divisions, and under the action of the sunlight reached a maximum deflection of 250 divisions, in the same direction as before. On the whole, the current seemed to vary with the intensity of the light, but several times it failed to do so.

Coloured glasses placed in front of the cell gave the most erratic and contradictory results. It seems, therefore, desirable to dispense with the use of collodion in these experiments.

When a platinum plate was coated with collodion and immersed in presence of another uncoated platinum plate in a cell containing tap water, the motion of the spot produced by sunlight was very much smaller than in the previous case; this motion extended over only 20 divisions of the scale. The small result here might, no doubt, be due to a Grove's current.

It ought to be mentioned that platinum plates coated with eosine give results very much smaller than those given by silver plates under the action of light. This fact, however, does not seem to me to be conclusive against the notion that a fluorescent body, in virtue simply of its fluorescence, can effect a transformation of luminous into electric energy; for while a silver plate, by its molecular arrangement, may be a suitable vehicle for the transference, a platinum plate may not—quite irrespective of chemical action.

17. ACTION OF MORDANTS.—To prevent the solubility of the eosine-gelatine film, the plate was washed with a solution of borax. A solution of chloride of aluminium was also tried. But, though these solutions kept the eosine in the film, they almost completely destroyed its sensibility to light.

The nearest approach to success was made by immersing the plate, which had been coated with a mix-

ture of eosine and photographic gelatine, in a strong solution of alum for some minutes. When this film had set, it answered remarkably well to the action of sunlight, and after long immersion no perceptible quantity of eosine had come off the film. The currents produced with this plate were not nearly so strong as those produced with an eosine plate prepared in the previous way, but strong sunlight gave a deflection of about half the length of the scale. About three minutes after the light was shut off, the spot returned to the point from which it started. The plate was left exposed to sunlight for over two hours, and after this time the water in the cell was not visibly coloured, although a very small quantity of eosine would have been sufficient to colour it.

With this plate the D.C. had so far disappeared after a quarter of an hour, that the spot came to 30 divisions of the scale from zero.

(*To be continued.*)

## ON CURRENTS PRODUCED BY FRICTION BETWEEN CONDUCTING SUBSTANCES, AND ON A NEW FORM OF TELEPHONE RECEIVER.*

IN a communicatio to the Royal Society of Edinburgh, of date January 6th, 1879, I showed that "electric currents were produced by the mere friction between conducting substances." The existence of these currents can be easily demonstrated either by a telephone or a Thomson's galvanometer. I have since found that these currents are, for all pairs of metals which I have yet tried in the same direction as the thermo-electric current, got by heating the junction of the same two metals. They are also, approximately at least, stronger in proportion as the metals rubbed are far apart on the thermo-electric scale—the strongest current, as far as I have yet observed, being got by rubbing antimony and bismuth together. These observations clearly point to a thermo-electric origin for the currents; but it is possible that they may be due partly to the currents suggested by Sir William Thomson as the cause of friction, and partly, also, to contact force between films of air or oxide adhering to the surfaces of the metals.

Having ascertained that these friction-currents are of some strength and fairly constant, I proceeded to make several kinds of machine for producing currents on this principle. One of them consists of a cylinder of antimony, which can be rotated rapidly, while a plate of bismuth is pressed hard against it by a stiff spring. When this machine is included in the same circuit with a microphone and a Bell telephone, the current got from it is quite sufficient to serve for the transmission of musical sounds and also loud speaking. The transmitter which I have found most serviceable in my experiments is made by screwing two small cubes of gas-carbon to a violin, and placing between them a long stick of carbon pointed at both ends, the points being made to rest in conical holes in the carbon cubes. The looseness of the contact is regulated by a paper spring. This forms an excellent and handy transmitter for all kinds of musical sounds, and also serves very well for transmitting speech.

Seeing that friction between metals clearly produces a current, it seems natural to inquire if the converse held good, that is, if a current from a battery sent across the junction of two metals affected the friction of the one upon the other. I have tested for this in a variety of ways, and the results obtained leave me in doubt whether to attribute them to variations in the friction or to actual sticking produced by fusion of the points of contact through which the current passes. The most noticeable effect is produced when one of the rubbing bodies is a mere point and the other a smooth surface of metal. This led me to make a modification of the loud-speaking telephone of Mr. Edison, in order to get audible indications of changes of friction produced by the passing of a variable current. It consists of a cylinder of bismuth accurately turned and revolving on centres. The rubbing-point is made of a sewing-needle with its point bent at right angles, and its other end attached to the centre of the mica disc of a phonograph mouthpiece. It is evident that this is only a loose contact, which can be perpetually changed. When this apparatus is included in the circuit with the violin-microphone and three or four Bunsen cells, the violin sounds, as was to be expected, are heard proceeding from the loose-contact, even when the cylinder is not rotated. They are increased, however, in a remarkable degree by rotating the cylinder slowly, so much so that a tune played on the violin can, with proper care, be distinctly heard all over an ordinary room.

With regard to the explanation of this effect, it is evident that electrolysis can in no sense come into play, as is supposed to be the case in Edison's instrument. I am inclined to look for the explanation rather in the direction of the Trevelyan rocker, although the circumstances are considerably different in the two cases. In the rocker we have the heat passing from a mass of hot metal through two points of support to a cold block, whereas, in the other case, the heat is only intense at the points of contact, the rest of the metals being comparatively unaffected. The variations in the current produced by the transmitting microphone must cause corresponding variations in the heat at the point of contact of the needle with the cylinder, and this again produces a mechanical movement of the pressing point, as well as of the air surrounding it, sufficient to give forth sound-waves. If such be the case the effect should be different for different metals, those answering best which have the lowest thermal conductivity and also the lowest specific heat. That this is really so is shown by substituting cylinders of other metals for the bismuth, all other things remaining the same. In this way I have compared lead, tin, iron, copper, carbon, and find that they all give forth the simple loose contact-sound when the cylinder is stationary, but that it is only with bismuth that there is any very great intensification of the sound when the cylinder is rotated. Now, by consulting the appropriate tables, I find that bismuth is a fraction lower than any other common metal in specific heat, while it is much below them all in thermal conductivity. This seems to bear out my explanation to a certain extent.

* Abstract of a paper read before the Royal Society of Edinburgh, by James Blyth, M.A., F.R.S.E., on May 3rd, 1880.

## ON THE BEST FORM OF MAGNET FOR MAGNETO MACHINES.

By W. LADD.

(Read before the British Association, August, 1880.)

AT the British Association Meeting at Dundee, in 1867, I made some remarks upon different forms of magnets, and exhibited diagrams, showing by the lines of force—naturally arranged—the great superiority of the circular magnet where an armature is to be employed.

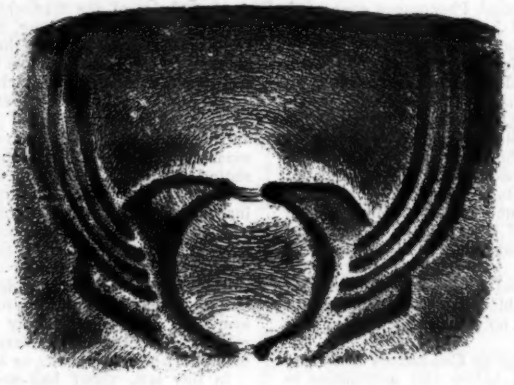

FIG. 2.

Since that time, some thousands of that form of magnet have been made for medical, mining, and other purposes.

Some months ago, in conversation with M. Breguet, of Paris, I showed him these same diagrams, and he was very much impressed with their import, ance; he has since then constructed a machine using the Gramme armature, and with a smaller quantity of steel in the magnets he has made a far more powerful machine than hitherto constructed with either the Jamin or the ordinary horse-shoe form. It is also more symmetrical in appearance and occupies less space.

With this machine I can heat to incandescence 19 inches of platinum wire by four turns of the handle, while to heat 14 inches of the same size wire by a machine having a Jamin magnet, it took ten turns of the handle.

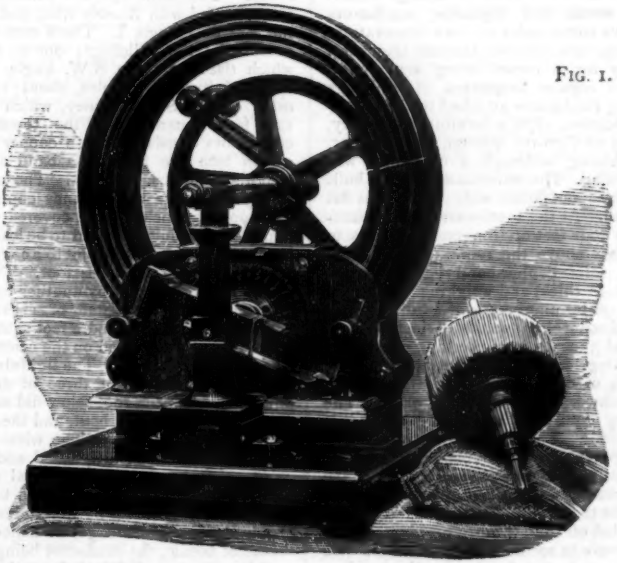

FIG. 1.

[This machine is shown by fig. 1. Fig. 2 shows the distribution of the magnetism about the field in which the armature revolves.]

## ON THE NECESSITY FOR A REGULAR INSPECTION OF LIGHTNING CONDUCTORS.

By RICHARD ANDERSON, F.C.S., F.G.S.

(Read before Section A of the British Association, August 27, 1880.)

ONE of the most valuable suggestions which has been made in connection with Lightning Conductors was that by M. W. de Fonvielle, in his paper "On the Advantages of keeping records of Physical Phenomena connected with Thunderstorms," read before this association in 1872. In that paper M. de Fonvielle referred to the steps taken by the French Government for having maps drawn of the course followed by thunderstorms; and he reminded the association that the French Academy of Sciences, as far back as 1823, recommended the Government of France to establish a record of cases of damage by lightning to buildings which had been supplied with lightning conductors. He pointed out that the efficiency of lightning conductors had been questioned, and that in Manchester, a conference, held on the occasion of Kersal Church being struck, had arrived at the conclusion that lightning conductors were worse than useless.

Although it was suggested by M. de Fonvielle, that this association should establish some organisation for the collection of such data, no results have, so far as I am aware, been published.

In my paper "On Lightning Conductors and Accidents by Lightning," read before this association in 1878, I cited two cases of damage to buildings provided with lightning conductors, which showed that on a careful investigation of the facts the lightning rods were inefficiently erected.

On the present occasion I wish to bring under the notice of the association a few cases of damage resulting to buildings which had lightning conductors attached, which have come under my own observation. The adducing of such cases furnishes the best argument, I imagine, not only for a record being kept of all accidents; but of a regular inspection of buildings which have lightning conductors attached to them.

On the 10th of October, 1878, a furniture repository, situated at the back of Victoria Station, Westminster, was struck by lightning, although a conductor was attached to the building. The warehouse, which is built of brick, is 110 feet by about 80 feet wide; the roof is flat and covered with lead. At the south-east corner a slate-covered tower, with four feet of iron cresting, rises to the height of 20 feet above the roof. To this ornamental ironwork a solid copper band lightning conductor, ¾" broad × ¼" thick, and weighing ·43 lbs. per foot, was attached. A terminal made of ½" dia. copper tube, with three discharging points 6 inches long, screwed into the rod 3 inches from the top, rose 3 feet above the iron cresting. The rod was attached to the ironwork by means of copper wire, and the band to the slates and brickwork by gun-metal clips. The copper was of very good quality, having a conductivity of 92·00 per cent. The electric discharge fell on the point of the lightning conductor, bending it, driving out two of the discharging points, and twisting the third. The iron cresting was shattered, and considerable damage done to the tower. Part of the discharge was, no doubt, carried off from the lead roof by the rain-water pipes, which were in metallic communication with it. On testing the conductor shortly after the accident I got no deflection of the galvanometer needle, and on opening out the earth terminal found the conductor carefully insulated in concrete.

On the 10th of June last, lightning struck the point of the conductor at St. Mark's Church, Skelton, slightly bending it, but did no further damage. The conductor was made of ½" dia. copper rope, and had a conductivity of 52·50 per cent. On testing the conductor, while rain was falling, I found the resistance to be 600 ohms. The conductor was buried 9" among bricks, lime, &c., and carried 15 feet from the building.

On Saturday, the 26th of June, 1880, a heavy thunderstorm passed over South Lambeth, the lightning doing considerable damage to All Saints' Church. The building in question, the style of which partakes of the characteristics of the thirteenth century, consists of a nave 92 feet 6 inches long, 25 feet wide and 36 feet high to the plate level of the roof, a chancel 31 feet long, 20 feet wide and 48 feet to the ridge; also north and south aisles 13 feet 3 inches wide. A stone cross 4 feet high stands on the apex of the west gable, and another of similar size stood 92 feet 6 inches from it on the east end of the nave, a ridge of red tiles separating them. A ½" dia. copper-rope conductor, consisting of 49 wires, was attached to the cross on the west gable, a 5 feet point, made of copper tube, rising 18 inches above it. On the afternoon of the 10th lightning was observed to strike the point of the conductor, then dart to the stone cross on the east nave, throwing it down and injuring the roof of the north aisle. On testing the conductor, a few days after the building was struck, I found the lightning rod had no "earth" whatever, the rope being simply stuck 2 inches in loose rubbish. The copper was very impure, the conductivity being only 32·10 per cent., or about double that of iron.

In July last, about half-past five in the morning, lightning struck one of the chimneys of Normanhurst Court, near Battle, Sussex, notwithstanding a lightning conductor was attached to it. Normanhurst stands on high land, and commands a magnificent view of the whole channel from the South Foreland to Beachy Head. The buildings are constructed of hard blue stone, roofed with Brosely tiles, and are in the style of the age of Francis I. There were two lightning conductors on the buildings; one on an octagonal tower which rises from the S.W. angle, having a balcony and a lofty stone spire, about 120 feet high; the other on the S.E. chimney, which was struck, about 126 feet distant from the tower. The lightning conductors consisted of 12 copper wires, 15 B.W.G., woven into the form of a band an inch broad, and weighing ·36 lbs. per foot. The air terminal, which rose 3 feet above the chimney coping, consisted of an iron point 12 inches long, covered with a composition which on scraping appeared to be lead, this was attached by means of a coupling-joint to a copper tube 6 feet long, and weighing ·28 lbs. per foot. The copper band was connected to the rod by another coupling-joint. The chimney coping consisted of eight ornamental stone pinnacles 3 feet high and 2 feet square at the base. The terminal rod was placed on the centre of the chimney—and insulated from it. The lightning discharge struck the chimney, destroying three of the pinnacles, which falling through the roof below did considerable damage. The air terminal was bent, and the composition on the point melted 3 inches. The wires near the terminal point were likewise partly fused, and on taking out one wire 25 feet below the terminal rod, I found it so irregular in thickness that it had to be redrawn before the conductivity could be determined. On testing the earth terminal I could get no deflection of the galvanometer needle, the conductor being buried in dry earth within a stone wall 8 feet above the fosse, or asphalted area. The conductor on the tower had "good earth." The conductivity of the copper was 80·5.

In my recently published work on "The History and Application of Lightning Conductors," the following cases, among others, are given.

On the 6th of August, 1878, lightning struck the powder magazine at the Victoria Colliery, Burntcliff, Yorkshire. At the time of the explosion the magazine contained about 2,000 lbs. of gunpowder. The magazine was an oblong building of brick, 9 feet long, 5 feet wide, and 6 feet high (internal dimensions), and it had a uniform thickness of three bricks. At the end was a heavy iron door, and at the other a lightning conductor, consisting of a copper wire rope seven-sixteenths of an inch in diameter. The point of the terminal rod was about 13 feet above the top of the building, and a similar length was carried into the ground, and terminated in clayey soil at a depth of three feet. The conductor was fixed to a pole distant about 2 inches from the end of the building opposite to that in which the iron door was fixed. *It was not connected with the iron door in any way.* On testing the conductivity of the copper rope it was found to be only 39·2 instead of 93 or 94 per cent. The conductor should not have been insulated, but brought down the pole, carried along the roof, down the iron door-post, and so into the ground.

In August, 1879, lightning struck one of the pinnacles of the tower of Cromer Church, Norfolk, although on another pinnacle only 27 feet 6 inches distant, a good copper conductor having a diameter of $\frac{3}{4}$ of an inch was placed. On testing the conductor by means of a galvanometer I found it and the earth connection in thorough order. In this case a point should have been placed on each of the pinnacles and joined to the main conductor.

In May, 1879, the steeple of the Church at Laughton-en-le-Morthen was struck by lightning and damaged. The spire, 175 feet in height, had attached to it a thin tube made of corrugated copper, about $\frac{1}{4}$ of an inch in external diameter and $\frac{3}{8}$ internal; the copper being $\frac{1}{32}$ of an inch in thickness. It was made in short lengths joined together by screws and coupling-pieces, but there was no metallic contact whatever between the pieces, which were much corroded. The conductor was not in contact with the building, but was kept at a distance of $2\frac{1}{2}$ inches by 21 insulators. The earth contact was obtained by bending the tube and burying it in the ground at a depth of from 6 to 18 inches, the soil being dry loose rubbish, the earth terminal being only 3 feet. It was placed in a corner formed by a double-stem buttress, which came between the conductor and a lead-covered roof attached to the spire; the distance between the conductor and the lead roofing being about 6 feet 6 inches. The lightning appears to have come down the conductor a certain distance, and finding the road to earth bad, it passed through the buttress, dislodging about two cartloads of stone, and then down the cast iron pipes leading from the lead-covered roof, and so to earth.

From the instances quoted, it is evident that it is not sufficient merely that rods of copper should be attached to a building, but it is necessary that once put up they should be regularly inspected to see if they are in good order, so as to be really efficacious. That this is rarely done is one of the main reasons why accidents by lightning occur in places nominally protected by conductors. It is, perhaps, not too much to assert that at present not one in a thousand of our public buildings in England are regularly tested.

There can be no manner of doubt that in the matter of lightning conductors they manage things better on the other side of the Channel than with us. The French Government are in the constant habit of consulting the most eminent scientific men on the subject of protecting public buildings against the destructive influence of lightning. There is scarcely an instance in which a British Government ever did such a thing. It is true the Houses of Parliament had lightning conductors erected upon them at a very great cost and under scientific advice. But all who understand the subject practically agree in saying that it is very doubtful whether the magnificent pile of buildings in which our legislators assemble is really, that is efficiently, protected. At all events, I understand the earths have never been tested since the conductors were erected in 1852. That the Victoria Tower should have been struck in June, 1868, and slightly damaged, tends to show that the conductors at that time were not in an efficient state.

From the examination I have made I am pretty correct in stating that one half of our cathedrals and three-fourths of our churches have not even nominal protection. For all that science has done, the Queen might any day be killed in her apartments at Windsor Castle, the Prince of Wales in Marlborough House, and the Prime Minister in Downing-street. To see the difference between England and France in this respect, one has but to cross the Channel between Dover and Calais. At Dover there are huge barracks of great length, on the top of high hills, exposed to the full fury of storms sweeping across the Channel, and the few conductors to be found upon them at long intervals are certainly not numerous enough for efficient protection against lightning, and their efficiency has never, so far as I can learn, been tested. The contrast in this respect on crossing the Channel is of the most striking. At Calais, the Hotel de Ville, in the Grand Place, literally bristles with lightning conductors, and so do all the churches and chief buildings in the town. The same all over France, Germany, and Belgium. Without slavishly imitating our scientific neighbours, we might yet bestow some of the care they do upon the protection of our property as well as of our lives against the terrible effects of the electric force.

## TROUVÉ'S ELECTRIC MOTOR.

By M. TROUVÉ.

If the dynamic diagram of a Siemens armature is traced out, on making the armature turn a complete revolution between the magnetic poles which react upon it, it will be observed that the work is almost nil during two periods forming a considerable portion of the revolution. These two periods correspond to the times during which the cylindrical poles of the armature, having reached the poles of the magnet, move in front of them. During these two portions of the revolution, which are each about 30°, the magnetic surfaces destined to react one on the other remain at the same distance, and the armature has no turning force given it.

I have suppressed these periods of indifference and increased the useful effect of the machine, by modifying the shape of the bobbin; the polar faces, instead of being portions of a cylinder of which the axis coincides with that of the system, are of a snail form, so that on turning they gradually approach their surfaces towards those of the magnet, up to the moment when the hinder edge leaves the pole of the magnet. The action of repulsion then commences, so that the dead point is practically got rid of.

Fig. 1 shows a general perspective view of a motor constructed on these principles; fig. 2 is a vertical section of the same, with a horizontal projection.

Fig. 1 is drawn to half size. A A C C is a fixed

electro-magnet or inductor; B a Siemens armature on the new principle mounted on pivots, I J.

This motor is capable of working a sewing machine with a few Bunsen or Reynier cells.

As matters exist at present, it is doubtful if this motor can be employed by a working mechanic, as the expense to him would be comparatively considerable; it would be, however, very useful to dentists or clockmakers, &c., or to amateurs, and for numerous special purposes. The success of this motor, and the different results arrived at, are easily explained by the following enumeration of the peculiarities which it presents: 1st, it gives in a comparatively small space a considerable power; 2nd, the electro-magnetic effects are utilised under the best possible conditions, as 6th, no sparking at the commutator, the current being never interrupted (it changes only as in the ordinary Siemens armature, at each revolution); 7th, it may be added that this motor is reversible, and can, by slight modifications, be employed as a generator of electricity; 8th, it is not expensive, costing from 100 francs upwards.

Figs. 3, 4, 5, are varieties of the motor, in which M. Trouvé has arrived at good results by making the inductor excentric, instead of the armature.

Fig. 6 represents an ingenious application of the Trouvé motor to the propulsion of light boats. The arrangement is in effect so simple that it does not require any change in the construction of the boat to be made.

The rudder carries on itself all the mechanical

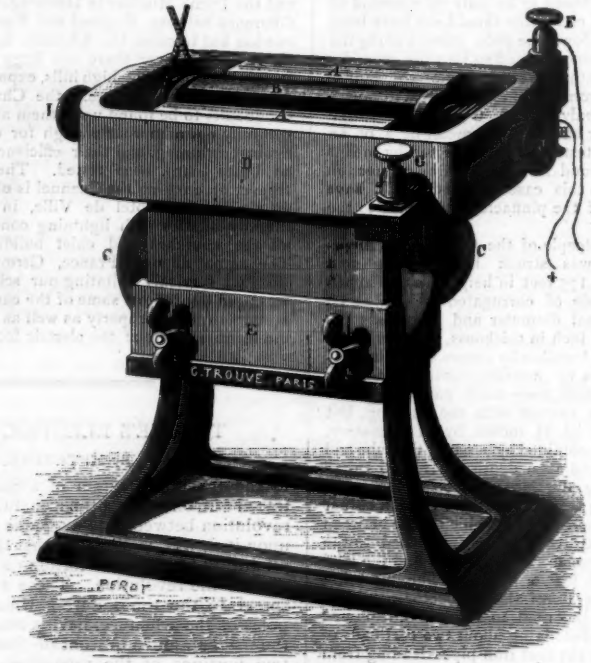


FIG. 1.

the inductor is very close to the induced armature, and since it almost entirely envelopes the latter. Fig. 2 shows a vertical section with a horizontal projection of the motor. *a a b* is an electro-magnet with two branches, and which forms the inductor; *f f e e* is the movable armature. 3rd, the complete suppression of dead points, with a single movable electro-magnet, a fact very rare in mechanism, which would have produced an immense effect in science if it had been applied to the steam engine instead of to an electric motor; 4th, the direct reaction of two magnets, the one on the other, placed in the same circuit, allows of the augmentation of the power indefinitely by an increase in the current strength—this power is only limited by the strength of the machine; 5th, a considerable velocity can be attained even up to 200 turns a *second* and beyond; elements; the motor, the propeller, and the conductors are easily added.

The screw and its axis occupy the lower part of the rudder, and receive the movement of the motor placed on the top of the rudder by means of a connecting band or by some other means.

The electro-motive force furnished by the generator which is placed in the boat is conducted to the motor by flexible metallic cords.

The power given out by the motor is transmitted to the axis of the screw by means of a band, as explained above.

The rudder is fitted to the boat in the ordinary manner, by a hook and loop.

It keeps in every respect its movability as an ordinary rudder; it allows besides the use of oars to increase the speed of the boat.

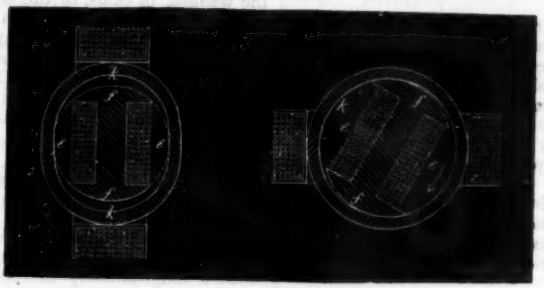

FIG. 4. FIG. 5.

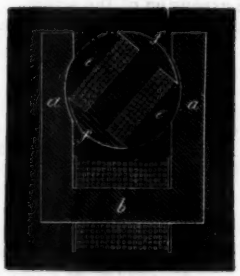

FIG. 2.

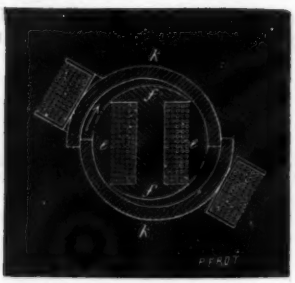

FIG. 3.

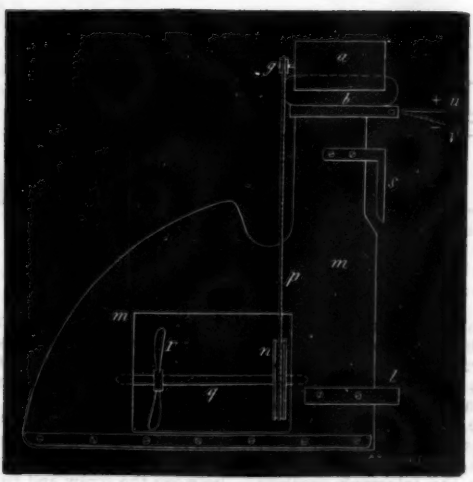

FIG. 6.

When it is required to use the oars alone, the screw not being acted upon by the motor can turn freely.

For several months numerous experiments have been made on the river Seine, with this motor arranged in the manner indicated, and fitted to a pair-oared yawl, the *Telephone* belonging to M. Ed. Schlesinger. In the experiment the yawl attained a speed of 1·20 metres per second. After certain modifications of details, this speed was successfully increased to 2 metres per second, with the stream against the boat.

These results were obtained with the small motor, of which fig. 1 is a half-size representation, presented to the Académie des Sciences; the battery power was 6 Reynier elements.

## BLOOMFIELD'S PATENT INSULATOR.

THIS insulator, the invention of Mr. John H. Bloomfield, of Concordia, Entre Rios, Argentine Republic, is designed specially for South America, to prevent breaking, from the expansion of the iron shank, in a climate subject to sudden changes of temperature, in which it is impossible to maintain the insulation of a line in a good state without frequent renewals. Where this insulator is used, the "Hornero," a species of "Furnarius" (F. rufus)—a bird well known in South America, which builds its nest of mud on the telegraph brackets and insulators—cannot cause "weather contact" or "earth;" on the contrary, by building its nest on the cross-arm or bracket, right over the insulator, it will improve the insulation, as its nest would be a protection in wet weather. Suspension insulators, in which the wire is hung in hooks, have this latter advantage also; but the wire breaks frequently in the wedges, or cams, of the stretching insulator in frosty weather, and runs down a long way through the hooks. They are also heavy and expensive, and liable, in common with all others, to be broken by the expansion of the hooks, hoods, or cement.

Fig. 1 is a side view of one of the improved insulators. Fig. 2 is a longitudinal section of the same.

A represents the insulator, which is designed to be made of glass, porcelain, or glazed brown ware, with a convexed upper end, a concaved lower end, and a downwardly-projecting cup-flange around its upper part covering the part around which the wire is to be fastened. The porcelain cup, A, is perforated longitudinally to receive the screw, B, by which it is secured to the lower side of the cross-bar, C, attached to a pole.

The perforation is made a little larger than the body of the screw, B, so that the porcelain cannot be broken by the expansion of the screw.

The lower end of the perforation through the porcelain is countersunk to receive the head of the screw, B, and the head has a square hole or cavity formed in it, in line with the axis of the screw, to receive a key for screwing it into and out of the cross-bar, C.

Upon the body of the screw, B, within the upper and lower parts of the perforation through the cup, are placed two rubber bands, to fill up the space between the screw and cup, and keep the latter firm and steady.

Upon the body of the screw, B, at its head, is placed a rubber ring, E, which is made a little smaller than the head, and which, when the screw is turned up into place, is pressed into the countersink in the

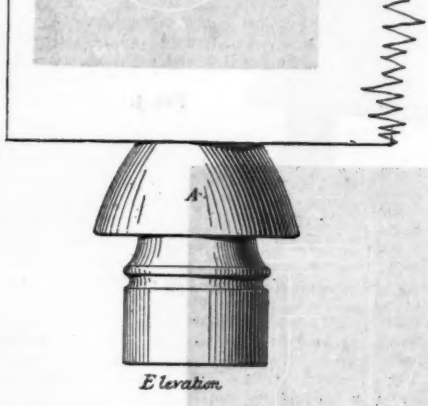

Fig. 1.
Elevation

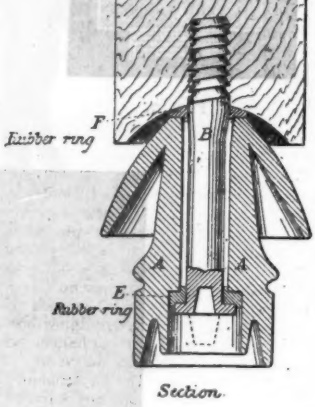

Fig. 2.
Section

porcelain, A, and around the outer edge of the screw-head, so as to cushion the screw-head and keep it from coming in contact with the porcelain cup.

Upon the screw, B, at the upper end of the porcelain, A, is placed a rubber ring, F, which, when the screw is turned up into place, is pressed into the upper end of the space between the screw and cup, and between the cup and the cross-bar, C, so as to cushion the insulator to the cross-bar.

By this construction the porcelain cup, A, is kept from contact with the screw, B, and the cross-bar, C, and the screw is allowed to expand without breaking A, and to contract without loosening it.

The under side of the cross-bar, C, is concaved to receive the upper end of the cup, A, to protect it from the weather.

With this construction, should an insulator be broken a new one can be secured in place with the same rubbers and screw that secured the old one, so that the line-repairer will only have to carry a small key and a number of insulators, no nails, hammer, screw-driver, screws, &c., being necessary.

Should it be desirable to use iron-hooded insulators, the "South American" can be made so, by placing a perforated inverted iron cup on the screw between the caoutchouc ring and the cross-arm or bracket; this gives all the advantages of the ordinary iron-hooded insulator, with none of its drawbacks.

The loss and waste of material is less with this insulator than with any other, as the parts are interchangeable, the screw and rings of one answering for the porcelain cup of another. This is an important consideration in ordering supplies for renewals, as only the parts required need be ordered, thus reducing the expense of maintenance and freight.

Where a wire is broken it often runs down from three or four poles on each side of the break, tearing off or breaking the insulators, and loosening the posts. A good deal of this would be avoided with the new invention, as, owing to the caoutchouc rings, each insulator acts as a spring, and lessens the shock.

Experience has shown that if a telegraph line is examined a month after it has been put in repair, particularly if there have been any frosty nights, followed by warm days, a good many insulators will be found cracked, loose, or with incipient cracks, showing that their efficiency as insulators is very much impaired; and if the lineman does his duty, he should carry a number of insulators with him, depending on the length of his line, every time he patrols it. With the above insulator all this would be avoided, as the insulator cannot be injured by the expansion of the screw. If this insulator were to get broken, the wire would not drop to the ground unless the porcelain was broken piecemeal, because the binding wire will keep the pieces together, and the head of the screw being underneath prevents them from slipping down.

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WE understand that Professor Graham Bell has arrived in England from America.

## TELEGRAPHIC APPARATUS IN USE IN THE BRITISH POSTAL TELEGRAPH DEPARTMENT.

### XVIII.

### A B C INSTRUMENT—(*continued*).

THE general arrangement of the internal and external connections of the A B C instrument will be seen from fig. 73. Fig. 74 shows the arrangement by which the currents from the Communicator are sent out to line and cut off.

As has been explained in the last article, when the revolving arm is hitched to the wheel driven by the Communicator, the arm, A, is pulled over from left to right. Now the end of the arm, A, is forked, and has two prolongations, *a* and *b*, the latter of which has a platinum tip. This tip then presses against the end of the lever, *l*, and makes contact with it; at the same time it presses away *l* from the contact screw fitted to the insulated column, F, and banks it against the screw fitted to the insulated column, E, the circuit is then complete between terminals 6 and 7, through the electro-magnets, thus: from 7 to E, thence through *l* to the arm, A, and one end of the coil of the electro-magnet, then through the latter to F and terminal 6. If now the arm, A, falls back, the fork, *b*, breaks contact with *l*, and the fork end, *a* (fig. 74), comes against the ebonite piece, *c*, fixed to the end of *l*, forcing the latter back against the stop screw fixed to F, if the spring attached to *l* has not already done so. The circuit now from 6 to 7 is complete, thus: from 7 to E, thence through *l* to F, and from the latter to 6. The electro-magnet coils are thus cut out of circuit.

It will be seen that the lever, *l*, cannot break away from the screw stop of F, until the end, *b*, of the arm, A, comes against *l* and forces it away, but when this occurs, the arm, A, must be in communication with *l*. There must, therefore, either be a short circuit between 6 and 7, or the coils of the electro-magnet must be in circuit, a disconnection between 6 and 7 cannot occur. In the old forms of apparatus the end of the arm, A, played between two contact points, one of which was connected to one end of the coils of the electro-magnet and the other to terminal 6; the arm, A, was connected to one end of the coils and to terminal 7 through the frame of the instrument. With this arrangement it sometimes happened that the arm, A, or "rocking lever," became set intermediate between the two contacts, thus causing a disconnection and breaking down the circuit, with the new form of rocking lever as described this never occurs.

The external and internal connections of the "Receiver" portion of the apparatus are shown in the upper part of fig. 73. The terminals and brass-plate connections are fixed to the back of the receiver. With the switch turned to (T) the course of the current, from terminal 7 of the communicator would be:—to terminal 3, thence through the switch lever to brass plate 5 and through the coils of the receiver, thence to brass plate 1 and on to the terminal connected to the latter; from there the current passes to the "Down" line.

When the switch lever is moved over to (A), then the course of the circuit from terminal 7 is:—to terminal 3, thence through the switch lever to brass

plate 4 and to the "Bell" connected to it. From the bell the circuit is complete to terminal 5, and thence through the communicator to the Down line.

Terminals 1 and 2 screw into a brass plate cut at *h*. In the case of a thunderstorm coming on a brass

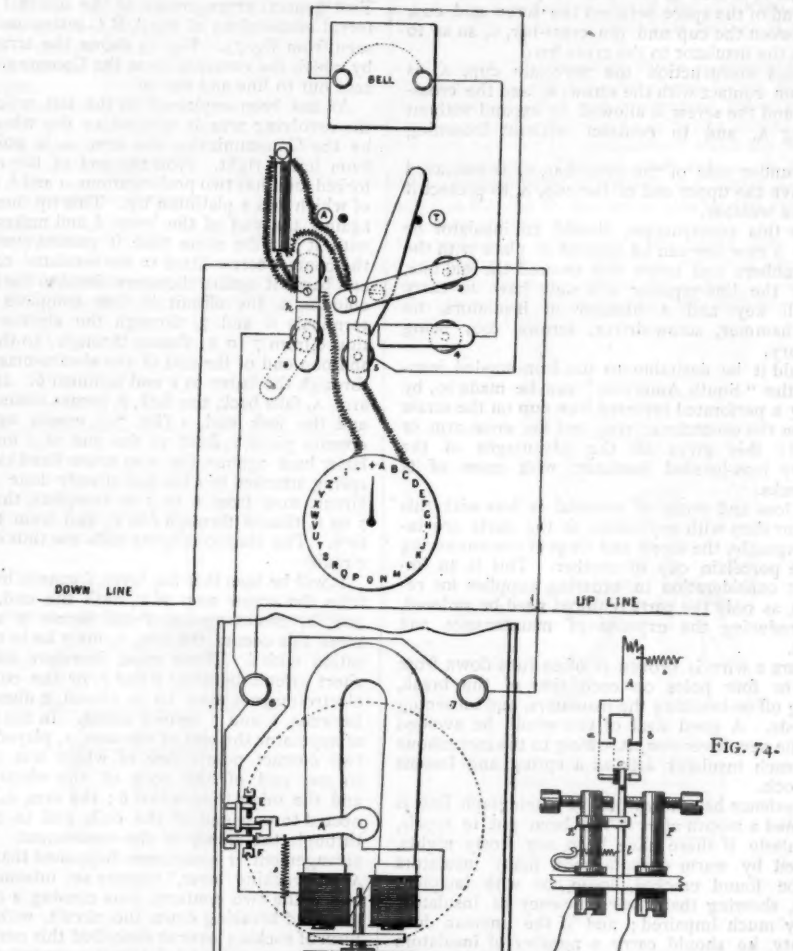


FIG. 73.



FIG. 74.

strap, s, can be made to connect the two, and thus the Up line be connected direct to the Down line and the instruments cut out of circuit and be prevented from sustaining damage.

The wires of the "lightning protector," which is fixed inside the receiver case, are connected to plates 1 and 3. The brass case of the protector is connected to a terminal placed immediately below terminal 4; this terminal is connected to earth.

The line connections shown are those for an "Intermediate" station. At an "Up" station, terminal 6 is put to earth, and at a "Down" station terminal 1 is put to earth.

### *Faults.*

Care must be taken that the switch lever makes a good rubbing contact with plates 4 and 5; it

occasionally happens that a disconnection takes place on one or other of these points. A contact in the lightning protector will interrupt the working of the apparatus. This fault can be ascertained by connecting a galvanometer and battery to terminals 1 and 3, the other terminals being free, and the switch turned to (A); no deflection of the needle should be produced.

There also should be no contact between the brass case of the protector and either of the terminals 1 and 3.

An A B C instrument, in good order, should work well on short circuit through a resistance of 11,000 ohms. The communicator coils are wound to a resistance of 500 ohms, and the receiver coils to a resistance of 150 ohms.

These instruments have proved so satisfactory that more than 10,000 have been manufactured. Over 5,000 are in use in the Postal Telegraph Department.

## THE ROYAL ENGINEER TELEGRAPH TRAIN AT ALDERSHOT.

THE Royal Engineer Telegraph Train at Aldershot, under the command of Major Hamilton, lately returned from the Zulu campaign, affords a gratifying instance of the smartness and efficiency attainable by our scientific corps from frequent actual practice in the field.

The equipment of the troop is contained in twenty-four waggons, each drawn by four horses, carrying two drivers, and attended usually by a non-commissioned officer and six men on foot. Six of the waggons are coaches fitted up as offices, while two others each carry a boat for crossing deep water. Thirty-six miles of india-rubber covered copper strand wire—the core 0·3 inches in diameter, and braided with hemp—for running out on the ground, and thirty-four miles of bare copper wire (No. 22 B. W. G.) for aerial lines, are carried on drums. Each drum contains half a mile of core, and six drums, revolving on fixed axes, are carried in the body of a waggon. Under the drums are placed twenty telescopic iron gas-pipe standards, eighteen feet long, for erection at road, stream, and canal crossings; three log-line stays, with iron spikes and wooden cleats, are supplied for straining up taut each standard, and a small wooden top-piece to contain the covered wire, with a wedge to prevent its hanging low over a crossing. On actual service, of course, any length of aerial line of copper or thin iron wire can be run up, and trees, bamboos, or such jungle props as can be obtained locally, would be employed for supports. This aerial line would follow in the rear of an advancing force, while the covered core would be used for running out on the ground to connect the flanks with the main body, and the latter with the reserve and baggage. In crossing an open country the ground line is run out at the respectable rate of five miles an hour, inclusive of stoppages for erection of pairs of telescopic poles at road crossings. While the waggons are on the move and the wire is being paid out the men busy themselves in putting it out of harm's way as much as possible—inside hedges and fences, behind furze bushes, over palings, on the roofs of cottages, or in covered trenches at crossings where the length of the poles is insufficient to carry the wire clear of baggage waggons. When the wire is to be recoiled the waggon is turned back over the same route as that by which it advanced; an india-rubber endless band is passed over the axle of the drum and over that of a wheel concentric with and fixed to the hind wheel of the waggon, so that as the latter progresses the wire is coiled on the drum; a man walks behind to let the wire pass through his hand (protected by a leathern glove), to remove timber and to guide it on to the drum.

The receiving instruments for the offices are "direct inkwriters," consisting of a lightning protector, a key, a galvanometer, and a polarised sounder, resembling a Siemens relay, turned on its side with the tongue lying horizontal, connected with the usual clockwork arrangement for paying out the tape; these are all on one base-board. These recorders will work through fifty miles of the wire used, but for field work are unnecessarily cumbersome and complicated; greater despatch would be secured were the men taught to read by sound exclusively from a small simple or polarised sounder. Such an instrument of 200 ohms resistance would work through 150 miles of wire with a small battery power, and would certainly be cheaper and more portable than that in use; and the time now expended in translating the message from the tape record would be saved.

The battery cells used are those of the Leclanché "Gravity" form, and are fitted into ordinary wooden troughs; one chamber contains zinc and a solution of sal-ammoniac, and the other carbon and peroxide of manganese; sawdust, well packed into the tops of the cells, prevents spilling of the solution. These batteries are worked on the "closed circuit" system, and it is a question whether small-sized Daniell's cells in troughs, excited by sulphate of copper, sal-ammoniac, or common salt, in default of other salts, would not be found more constant for a continuous current.

## Notes.

THE Secretary of the United Telephone Company, Limited, has written the following to one of the daily papers: "Referring to the 'communication' in yours of Saturday last, I am desired to inform you that the parties by whom no doubt it was made, and who constitute the so-called Gower Bell Company, represent one or more of the scores of telephone patents which have been taken out since (and therefore subject to) the original Bell and Edison patents, the latter being now invested in this company in the same manner as the corresponding patents for the United States are vested in the National Bell Telephone Company of America. The license held by the Gower Bell parties under the Bell patent is of a restricted nature, and is subject to the payment of a royalty to this company. They have no license under the Edison patent, and (as they have raised the question) it is but right to warn the public that their carbon transmitter is an infringement of this company's patents, and that all persons using it will be proceeded against as infringers."

With reference to the above, we have it on good authority that the Gower Bell Company have taken similar steps to those formerly taken by Mr. Crossley

under like circumstances—namely, they have issued notice of a writ of injunction to restrain the United Telephone Company from issuing any such circulars.

THE patent for the Crossley Microphone Transmitter has been sold to the Universal Telephone Company, Limited (Bell and Edison Companies combined), of London. We presume the already commenced legal proceedings of the Edison Company against Mr. Crossley will, in consequence, be abandoned.

THE law-suit between the Government and the Telephone Companies, we hear, is likely to come on about November. It is said the Government refuses any compromise before the action is tried, but is open to make good terms after it is decided.

MR. DAVID BROOKS of Philadelphia, who has been superintending the laying of his underground telegraphs at Waterloo, and on the Continent, was to sail on Saturday, the 25th ultimo, from Antwerp for home.

MESSRS. CLARK, MUIRHEAD & Co. are, we understand, about to manufacture the machines and lamps for the Lontin Company.

A STATEMENT has been going the round of the papers to the effect that "Messrs. William Cooke & Co., Limited, of Sheffield, have just secured the largest Government order for telegraph wire that has been given out for many years. The order amounts to about £20,000, and the wire is intended for telegraph purposes in India." This is undoubtedly a very nice order, but the statement is incorrect. Even so recently as this year a larger order was placed by the Government for about £23,000 worth of wire, the contract being made with the well-known manufacturers, Messrs. R. Johnson & Nephew, of Manchester and London.

MR. FAWCETT, the British Consul-General at Constantinople, has been notified that the assassins of Mr. Anderson, the agent of the Eastern Telegraph Company in Crete, have been sentenced to fifteen years' imprisonment.

MESSRS. SAMUEL BROTHERS, of Ludgate Hill, who, previous to the destruction of their premises, used the Jablochkoff system for the illumination thereof, have now contracted with the "Compagnie Generale" to light their new warerooms on the Jamin system. They decided on this method after having received a very favourable report of the use of that system in Paris, by the firm of carriers called the "Messageries Nationales," and at a music hall; the said report being furnished by a scientific gentleman whom they instructed to witness and examine the light at those places.

THE Edinburgh Police Commissioners have accepted the tender of the United Telephone Company for connecting telephonically the head police-station with the district stations, and the Edinburgh and Leith head police-stations. The erection of the wires is being rapidly pushed forward. The wires at present connecting these places are worked with Wheatstone's A B C's, and are maintained by the post-office.

THE port of Havre will shortly be illuminated by the electric light, the Minister of Public Works having sanctioned the agreement with the Societe Generale d'Electricite.

MESSRS. HARRISON & SON, of Darlington, have recently put the ironstone mines of Messrs. Stevenson, Jaques & Co., at Boosbeck, in telephonic communication with the smelting furnaces at Acklam, a distance of about 15 miles. The wires pass through Messrs. Stevenson, Jaques & Co.'s offices at Middlesbro', where a set of telephones are also fixed, and the three places —Boosbeck, Middlesbro', and Acklam—can thereby carry on a conversation with each other all at the same time, and orders may be verbally given from the central office at Middlesbro' to both places at once, or to each separately, as may be desired. The speaking, which is most distinct, is transmitted by Hunnings' Patent Micro-telephones, and the effects of induction from contiguous telegraph wires are stated to be entirely overcome by it. In addition to this communication between Acklam, Middlesbro', and Boosbeck, a wire has been carried down into the mine itself, and it is thereby possible for the people at the furnaces at Acklam, or in the offices at Middlesbro', or Boosbeck, to speak direct to the men in the mine itself at Boosbeck.

THE machines of the Brush Electric Light Company in Montreal Harbour, having successfully stood the long-continued tests to which they have been subjected, have finally been taken over by the Harbour Commissioners. They have ordered besides five additional double lamps, making in all twenty-one lights which will be available for illuminating purposes.

THE Herz Telephone and Induction apparatus, which is stated to have successfully solved the problem of telephoning through submarine cables, was patented in this country in July and August last.

FROM some experiments made by Dr. Obach, it appears that the electrical resistance of selenium is affected by phosphorescent light, though to a small degree only.

THE Museum of Practical Geology in Jermyn-street, is, it is said, to be illuminated by the electric light during the coming winter.

THE Swiss Federal Council, granting a concession to a Telephone Exchange Company in Zurich, have fixed the duration of the grant at twenty years, whilst a tax is imposed of 10 francs (8s.) for each subscriber.

THE Anhalt Railway Company has adopted the Bell telephone as a means of communication between its offices and stations.

AT the recent meeting of the British Association, a committee on Electrical Standards was formed, consisting of Lord Rayleigh, Sir W. Thomson, Professors Adams, Ayrton, Foster, Fleeming, Jenkin, and Perry, Messrs. Hockin, Hopkinson, Lodge, Muirhead, and Preece. The principal object of the committee is to revalue the ohm.

EIGHT miles of the track on the Canden and Amboy Railway, New Jersey, are to be worked experimentally by electricity. The experiment will be looked forward to with great interest.

A SMALL pamphlet on "The Electric Light for Industrial Uses" has been published by Mr. R. E. Crompton. The pamphlet contains a great deal of useful, practical information.

A COMPANY is to be formed in America, with a capital of 4,000,000 dollars, under the title of "The American Rapid Telegraph Company." By the use of improved automatic instruments a rate of 1,000 words

per minute is to be attained. The system is the invention of Messrs. T. M. Foot, C. H. Randall, and F. Anderson.

BROOKS' CABLE.—Some recent tests of the Paraffin Oil Cable, laid down by Mr. Brooks some months ago in Belgium, show very satisfactory results. The following are the tests:

| Dates. | Resistance in megohms per kilometre, after 10 minutes' electrification. | Temperature. | Weather. |
|---|---|---|---|
| 4/6/80 | 361 | 12½° C. | Rain. |
| 19/6/80 | 211 | 23½° C. | Fine. |
| 25/6/80 | 290·8 | 17½° C. | Rainy. |
| 2/7/80 | 277·38 | 21½° C. | Fine. |
| 10/7/80 | 237·9 | 16° C. | Rainy. |
| 16/7/80 | 365·8 | 18°—21° C. | Rainy and stormy. |
| 27/8/80 | 209·7 | 14½° C. | Fine. |
| 3/9/80 | 205 | 28° C. | Fine. |
| 13/9/80 | 249·2 | 19° C. | Fine. |

The tests were taken by M. J. Dumont.

THE Western Union Company is now engaged in building an entirely new line of the largest wire used for telegraphic purposes, which is to be quadruplexed and used exclusively for cable business.

ON Wednesday, September 8th, lightning fell on the Sorbonne at about half-past two o'clock. A globe of fire was observed by persons present on the spot. Some of them say it was seen coming from the point of the north-western conductor, which was struck, as well as the south-western, with a great noise. The Sorbonne had, until recently, no lightning conductor, and never, as far as is known, has any thunderbolt struck the venerable abode of the French University. But within the last few months six stems have been erected and connected by an iron bar, making a circuit which goes all over the roof of the immense building. Unfortunately, the pit where the earth conductor has been placed is situated at a great distance from the main building, in a courtyard adjoining the laboratory of M. Jamin, and the conductor which connects the roof with this is a square iron box of less than 15 mm. on each side, so that there is not sufficient conductibility in it to establish an efficient connection with the earth. This accident proves the sagacity of M. Karsten, the Schleswig-Holstein physicist, who published a table giving a formula for regulating the dimensions of the connecting-rods with their lengths, as is taught by Ohm's laws. It shows also how little the knowledge of lightning-conductors is spread in France, in spite of the several official commissions which have been established by the Government.

DURING the severe thunderstorm which recently passed over North London, a peculiar phenomenon was witnessed in the grounds of the Welsh Harp, Hendon, by some gentlemen boating on the lake. A vivid flash of lightning was succeeded by a tremendous peal of thunder, a great ball of fire at the same time descending from the heavens into the water. When the storm had abated, over 100 fish of various kinds, including two fine carp, weighing together 23 lbs., were found floating dead on the lake.—*Nature.*

CHARTERHOUSE SCIENCE AND ART SCHOOL AND LITERARY INSTITUTE.—We have been requested to state that the winter session of this, the largest science school in the United Kingdom will, under the continued presidency of the Rev. J. Rodgers, V.C. of the London School Board, commence on Saturday, the 25th of September. During the late session about 800 students availed themselves of the privileges afforded by this institution, and of this number nearly 600 presented themselves for examination, and were successful in obtaining no less than 140 Queen's Prizes, awarded by the Science and Art Department of South Kensington. At a nominal fee instruction of a practical character is given in most of the sciences, whilst in art, at an equally low rate students, under the direction of four competent instructors, can be advanced in their studies. Those who aim at becoming proficient in chemistry (organic and inorganic), have the opportunity of working in a well-fitted laboratory, capable of holding sixty students. Aspirants for University honours can, at a small expense, be assisted in their studies. Lessons in Latin, Greek, French, German, and music, are given by well qualified teachers. Full particulars can be had of the organising secretary, C. Smith.

TELEPHONE CONVENTION.—Arrangements have been made at the International Hotel, at Niagara Falls, at a reduced rate, for delegates to the Telephone Convention, which is to be held there on the 7th inst. The hotel proprietors will furnish a room for the meeting of the convention, and have a number of excellent rooms where manufacturers and dealers can display their apparatus, &c., for the use of which they can make favourable arrangements.

The coming convention will open the eyes of a good many to the vast importance of this new branch of telegraphy. It is not long since the telephone compelled the British Government to call a halt—when the latter attempted to interfere with the introduction of the system in England—and in this country its importance has scarcely received the recognition which it deserves. It is barely more than a year since telephone stock advanced from 50 dollars to 1,000 dollars a share—at which price it was privately marketed last summer—and most people will be astonished to learn of the remarkable growth of the system. At the beginning of 1879 the Bell Telephone Company had in use in America about 12,000 telephones; a year later it was working 50,000, and there are now in use upward of 85,000 instruments of its own manufacture, and, perhaps, 25,000 from the Western Union offices. We should not be surprised to hear that by next New Year's they have 200,000 instruments in use, and five years hence a half a million will probably be found in active operation.—*Magnet.*

THE system of underground pipes for telegraph wires in Berlin consists of 33,373 m. iron pipes and 460 m. passages of mason-work, and contains 155 apertures for examination and repair of the lines. The cost amounts to 229,867 marks.

## Correspondence.

S.—We have lost all record of the source from whence the note in question was derived; but we fancy that Professor Jenkin and Ewing's experiments on "Current curves from sound waves" were described in a number of *Nature* of about the date when the note was written.

# New Patents—1880.

3765. "Improvements in electric lamps and in carbons or incandescing conductors therefor, and in means for and methods of manufacturing the same." E. G. BREWER. (Communicated by T. A. Edison.) Dated Sept. 16.

3784. "Electric type-printing telegraph apparatus." G. J. DROSTE. Dated Sept. 18.

3808. "Dynamo machines." F. G. WILLATT. Dated Sept. 20.

3809. "Improved means and apparatus for dividing and subdividing the electric current for lighting purposes." J. B. ROGERS. Dated Sept. 20.

3832. "Improvements in or applicable to dynamo-electric machines." W. ELMORE. Dated Sept. 22.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1880.

455. "Lamps for electric lighting." T. H. BLAMIRES. Dated Feb. 2. 6d. Describes forms of lamps in which the production and maintenance of a vacuum is obtained by means of one or more columns of mercury, the passing of the conducting wires through the glass being obviated, and Sprengel and air pumps being dispensed with.

471. "Telephonic apparatus." H. H. LAKE. (A communication from G. L. Anders and T. A. Watson, of U.S.A.) Dated Feb. 3. 6d. Provides at each station a switch permanently connected to line, which switch can be moved so as to connect the line to earth at each station, or to disconnect the line from earth; an electro-magnet operated by the main line current, and moving the switch by the return movement of its neutral armature when the current through the said electro-magnet is broken; a polarised armature affected by the main line current, and arranged so as to determine the movement of the switch in one or the other direction according to the polarity of the current, by the interruption of which the movement of the switch is effected by signalling apparatus operated by alternate positive and negative currents of such force or duration as not to attract the neutral armature; and a locking device which prevents the signalling apparatus at any station from being operated except when the line is grounded at that station.

478. "Electro-magnetic and dynamo-electric machines." T. MORGAN. (A communication from Nicolas Glouchoff, of Moscow.) Dated Feb. 3. 4d. This specification describes machines based, so it states, on the following principle—namely, that all galvanic currents, induction and Ampère, have an angular direction imparted to them, which arrangement enables the number of conductors to be reduced to a minimum, thereby diminishing the objectionable resistance, and at the same time enabling the whole of the copper or iron wire employed for working the machine to be utilised to the best advantage. Commutators are replaced by continuous metal discs, simple rubbers, or even troughs containing mercury, serving to conduct the current to the exterior of the apparatus. (*Provisional only.*)

495. "Method of and telephone for determining the direction of sound." A. M. CLARK. (A communication from A. M. Mayer, of the U.S.A.) Dated Feb. 4. 6d. Describes the topophone, which invention incidentally includes means of adjusting two resonators at variable distances from each other; means of varying the lengths of one or both of two connecting tubes; a suitable frame for the support of the various parts of the apparatus, affording an axis of oscillation which is substantially perpendicular to a line drawn from one resonator to the other, and a pointer which is substantially perpendicular to the axis of oscillation and to a line drawn from one resonator to the other. The invention may be employed either upon land or water, but its principal object is to facilitate the safe navigation of a vessel in a fog. In the latter case a base line is obtainable by sailing the vessel an observed distance in a straight line from one point of observation to the other. The resonators are first tuned to the pitch of the sound to be observed, by sliding their telescopic joints in or out until the normal pitch of the resonator corresponds to the pitch of the sound to be observed. The resonators are then adjusted equidistantly from the shaft, at a distance from each other slightly less than the wave-length of the sound under observation. The shaft, being then held in an upright position, is slowly rotated upon its longitudinal axis until the mouths of both resonators touch the same sound-wave surface. The observer, having the ends of two tubes from the resonators applied to his ears, will perceive a sudden augmentation in the intensity of the sound when the mouths of both resonators touch or nearly touch the sound-wave surface. The position of the pointer then coincides in alignment with a line drawn from the source of sound through the place of observation.

553. "Regulators or lamps for the electric light." G. W. WIGNER. Dated Feb. 9. 8d. Consists in the use of a fluid—such, for instance, as water—contained in a reservoir situated above the regulating apparatus, or of fluid under sufficient pressure to force it to a height greater than that of the regulating apparatus, as the motive-power by which the electrodes are caused automatically to approach each other, and in the use of the electric current itself or a portion of it to automatically regulate the supply of this fluid.

578. "Electric lamps." T. ALVA EDISON. Dated Feb. 10. 8d. Refers to incandescent lamps, and describes a method of manufacturing them so that a stable vacuum may be maintained therein.

583. "Electric railways, &c." CARL HEINRICH SIEMENS. (A communication from Dr. E. W. Siemens.) Dated Feb. 10. 6d. See TELEGRAPHIC JOURNAL, Feb. 15, 1880.

602. "Utilisation of electricity for light, heat, and power." T. ALVA EDISON. Dated Feb. 11. 8d. Relates to a method for supplying electricity generally to a city, town, village, or locality. These may form one district, or, if the extent of territory makes it desirable, may be divided into several districts. In each district is provided a central station, at which are grouped a suitable prime motor or several motors, each motor driving a number of magneto-electric machines. The inventor makes his field of force magnets extremely long, and of an extremely large mass of metal in proportion to the mass of metal in the revolving armature carrying the generating coil. By this extra length, as the magnetic tension at the poles increases with their distance apart, there is secured at the polar extensions acting upon the coils in the revolving armature a much greater magnetic intensity, or, so to speak, a greater magneto-motive force or pressure, causing consequently the generation of a greater amount of energy in the coils operated on than would result from the use of shorter magnets. By this elongation of the cores the inventor is enabled to dispense with a number of layers of coils, as one layer of wire is usually sufficient,

whereby the resistance of the machine is largely diminished. The large mass of these magnet cores is magnetically saturated by a weak current passing around them. It takes this weak current a long time to bring this mass of metal up to the point of practical maximum magnetic intensity; but once brought to that point, the weak current readily keeps them there, while with a shorter magnet a stronger current would more speedily magnetically saturate them: this stronger current would still be required to keep them so saturated. The claims number thirteen.

624. "Manufacture of engine packing, insulated telegraph wires, &c." G. F. JAMES. Dated Feb. 12. 2d. Refers to the hopper or funnel of the braiding machinery hitherto employed in the manufacture of engine packing, &c., in which china, clay, or other lubricating powder or liquid is introduced, and forms either a core or coating of the same. (*Provisional only.*)

630. "Lighting by electricity." The Hon. R. T. DUDLEY BROUGHAM. Dated Feb. 13. 2d. Intended to reduce the rate or to prevent the consumption of carbon or other electrodes used in electric lighting. The inventor combines the electrodes with a liquid carbonaceous substance, such as an oil or syrup, by immersion before or during the use in the lamp, or by supplying or feeding such carbonaceous substance to the electrode while the lamp is in operation. During the emission of the lights the volatile constituents of the carbonaceous liquid are driven off by the heat generated by the electric current, and the carbon is left in or on the electrode. (*Provisional only.*)

631. "Telephones and phonographic apparatus." F. H. F. ENGEL. (A communication from Dr. W. Klinkerfues, of Göttingen.) Dated Feb. 13. 6d. Consists in the application of an uninterrupted galvanic current to speaking telephones whilst in use. The application of one or more metal tubes filled with mercury, into which dip platina pins (which pins have broad bases), either connected to the diaphragm of the instrument or moved by its oscillations, for the purpose of producing a contact of vibrating or varying size. Also consists in the reinforcement of the variations of the current by several imitating diaphragms of several telephones intercalated between the elements of the battery, and in the gathering of the sounds or words of all imitating diaphragms in one hearing trumpet.

636. "Producing the electric light." A. M. CLARK. (A communication from C. L. Pilleux, of Paris.) Dated Feb. 13. 6d. Consists in the interposition between two ordinary rheophores of one or more carbons, whereby (according to their number and distances apart) either a single luminous arc is formed by the juxtaposition of two sparks, or two luminous points united by a voltaic arc extending between the points of the carbons placed between the rheophores, but without traversing the length of the said carbons.

638. "Electric telegraph apparatus." W. R. LAKE. (A communication from B. Thompson and C. Selden, of Toledo, U.S.A.) Dated Feb. 13. 6d. Relates, first, to means for the sending of telegrams by induced currents of opposite polarities, one polarity being required to close a reading magnet, and the other polarity being required to open the reading magnet. Secondly, it relates to the application of a condenser to multiple telegraphs, by which means the static charge of the line may be completely neutralised, and the reversals of battery from distant station, when working multiple telegraphs, are bridged over on the home relays.

695. "Cables or conductors for telephonic or telegraphic purposes." W. R. LAKE. (A communication from C. E. Chinnock, of Brooklyn, and J. de Hart Harrison, of Newark, U.S.A.) Dated Feb. 17. 6d. The principal object is to more effectually preclude the transmission of messages from one line-wire or conductor to another in its vicinity, and thence to any but the desired destinations. Also to carry off all currents caused by escape or induction from an outside source, and thereby prevent them from interfering with the transmission of messages along the line-wires. To these ends the improvements consist in the combination with a line-wire or conductor provided with an insulating covering, and with an external electric conductor of an uninsulated conducting wire independent of the said line-wire or conductor, but in electrical communication with its external electric conductor, and in communication with the ground, whereby electric currents caused by escape or induction from an outside source are carried off to the independent conductor, and thence to the ground at any suitable points; also of various modifications of above.

699. "Apparatus for preventing the injurious effect of induced or escaping electrical currents in telephonic or telegraphic lines." W. R. LAKE. (A communication from C. E. Chinnock, of Brooklyn, and J. de Hart Harrison, of Newark, U.S.A.) Dated Feb. 17. 6d. Comprises the combination of insulators sustaining the conductors, and supports therefor, in electrical communication with each other through a guard or other wire or wires in common to said supports, and in communication with the ground, whereby in a simple manner provision is made for carrying off escaping or induced currents at various points.

725. "Distributing currents for electric lamps or candles." J. IMRAY. (A communication from La Société Générale d'Electricité, Paris.) Dated Feb. 18. 6d. Relates to an arrangement of disconnecting and commutating apparatus, such that if one of a number of lamps should be extinguished or its carbons be consumed, this lamp is automatically thrown out of circuit and the next is brought into circuit, and consists of a strip of metal in U form inverted, which the heat causes to unbend and brings in contact with a screw; also in a commutator for bringing the candles successively into circuit.

751. "Telegraph wires." F. J. CHEESEBOROUGH. (A communication from A. K. Eaton, of Brooklyn, U.S.A.) Dated Feb. 20. 6d. Consists of a telegraph wire incased in a lead tube, and covered with a spongy coating, such as asbestos or mineral wool, between the sheathing and the wire, and filled or consolidated with an insulating material introduced in the spongy coating in a fluid or liquid state obtained by heat; also in a special process for incasing and insulating the said wire.

## City Notes.

Old Broad Street, September 28th, 1880.

DIRECT SPANISH TELEGRAPH COMPANY, LIMITED.—The report of the directors for the half-year ending 30th June, 1880, to be presented at the general meeting of shareholders, to be held on Thursday, the 30th September, 1880, states that the accounts for half-year ending 30th June, 1880, show a balance to the credit of profit and loss account of £3,559 13s. 3d. As the Bilbao cable was interrupted during the first 2½ months of the half-year, the traffic receipts (£5,573 17s. 11d.) may be considered satisfactory. The cables of the Company continue to work perfectly, and their electrical

condition is as high as ever. In consequence of arrangements with the postal telegraphs, it has been decided to exchange traffic with the department at Falmouth, instead of at the Lizard, and an underground line is being constructed by the Company between these two points. This work is being executed at a comparatively small cost, as some cable recovered from the Bay of Biscay last year, and suitable for this purpose, is being utilised. As will be seen by the accounts, the cost of repairing the Bilbao cable was £5,209 13s. 3d., and has necessitated the withdrawal of £759 10s. 10d. from the reserve fund. The accumulated dividends on the preference shares up to 30th June amount to 20s. per share. The balance of £3,559 13s. 3d. at the credit of profit and loss enables the directors to recommend that 10s. per share thereof be paid, and that £638 3s. 3d. be added to the reserve fund, which will then amount to £2,078 12s. 5d. The next remittance from the Spanish Government for the June quarter is expected at the beginning of November, when the dividend warrants will be issued to the preference shareholders.

THE Eastern Extension Telegraph Company notify that the accounts of the Company to the 30th June last show (subject to audit) a balance of profit of £95,535 for the half-year, out of which the board have already paid one interim dividend of 2s. 6d. per share, and they have this day declared another of a like amount for the quarter ending June 30th, together with a bonus of 1s. per share, payable on the 15th of October, making a total payment of 3 per cent. for the half-year. A balance of £35,610 is carried forward.

MR. C. M. HOOPER, the Secretary of the W. I. and P. Telegraph Company, writes to us, under date August 31, as follows:—In consequence of the unusually numerous interruptions to the cables of the West India and Panama Telegraph Company, their ship permanently stationed in the West Indies has been unable to overtake the repairs, and the directors have, consequently, found it necessary to send out a second ship to assist. The new ship will sail in about five weeks, on the completion of the necessary alterations and fittings, and will take out with her a further supply of new sheathed cable.

AN arrangement has now been arrived at between the Anglo-American, the Direct, and the Compagnie Française. The tariff from October 1st is to be the same for all, namely 2s. per word. The two first named Companies are to take 84 per cent. of the total receipts of the three, and the new Company is to have the remaining 16 per cent. as its share. There will be special rates for press messages.

The following are the final quotations of telegraphs:—Anglo-American Limited, 64¼-64¾; Ditto, Preferred, 95½-95¾; Ditto, Deferred, 35¼-35½; Black Sea, Limited, ——; Brazilian Submarine, Limited, 9⅜-9½; Cuba, Limited, 9¼-9⅜; Cuba, Limited, 10 per cent. Preference, 16¼-16½; Direct Spanish, Limited, 1⅝-2¼; Direct Spanish, 10 per cent. Preference, 11⅝-12¼; Direct United States Cable, Limited, 1877, 12⅛-12¾; Scrip of Debentures, 103-105; Eastern, Limited, 9⅜-10; Eastern 6 per cent. Preference, 12¼-12⅝; Eastern, 6 per cent. Debentures, repayable October, 1883, 106-109; Eastern 5 per cent. Debentures, repayable August, 1887, 103-106; Eastern, 5 per cent., repayable Aug., 1899, 103-106; Eastern Extension, Australasian and China, Limited, 9⅜-10¼; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-111; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, 104-106; Ditto, registered, repayable 1900, 105-107; Ditto, 5 per cent. Debenture, 1890, 102-104; Eastern and South African, Limited, 5 per cent., Mortgage Debentures redeemable 1900, 102-104; Ditto, ditto, to bearer, 102-104; German Union Telegraph and Trust, 9¼-9⅝; Globe Telegraph and Trust, Limited, 6⅜-6⅞; Globe, 6 per cent. Preference, 12¼-12⅝; Great Northern, 9⅝-10⅛; Indo-European, Limited, 25-26; London Platino-Brazilian, Limited, 4½-5; Mediterranean Extension, Limited, 2⅝-3¼; Mediterranean Extension, 8 per cent. Preference, 10¾-11¼; Reuter's Limited, 10-11; Submarine, 240-250; Submarine Scrip, 2¼-2½; West Coast of America, Limited, 2⅜-2⅝; West India and Panama, Limited, 1⅛-1⅜; Ditto, 6 per cent. First Preference, 6¾-7¼; Ditto, ditto, Second Preference, 6¼-7; Western and Brazilian, Limited, 7¼-7½; Ditto, 6 per cent. Debentures "A," ——; Ditto, ditto, ditto, "B," 96-99; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 120-125; Ditto, 6 per cent. Sterling Bonds, 101-103; Telegraph Construction and Maintenance, Limited, 34¾-35¼; Ditto, 6 per cent. Bonds, 106-109; Ditto, Second Bonus Trust Certificates, 3¼-3⅝; India Rubber Company, 15¼-16; Ditto 6 per cent. Debenture, 105-107.

## TRAFFIC RECEIPTS.

| Name of Co. with amount of issued capital, exclusive of preference and debenture stocks. | Anglo-American Co. £7,000,000. | Brazilian Sub. Co. £1,300,000. | Cuba Sub. Co. £160,000. | Direct Spanish Co. £116,379. | Direct U.S. Co. £1,213,900. | Eastern Co. £3,697,000. | Eastern Ex. Co. £1,997,500. | Gt. Northern Co. £1,500,000. | Indo-Euro. Co. £435,000. | Submarine Co. £338,225. | West Coast America Co. £300,000. | Western and Brazilian Co. £1,398,200 | West India Co. £883,210. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ |
| | | a | | | | | | | | | | a | |
| August, 1880 ... | * | 10,417 | 2,000 | 1,197 | * | 42,988 | 30,249 | 22,800 | ... ... | * | ... ... | 8,612 | 1,792 |
| | | a | | | | | | | | | | | |
| August, 1879 ... | 51,300 | 9,880 | 2,557 | 996 | 17,100 | 36,257 | 26,242 | 16,800 | ... ... | 10,789 | ... ... | 11,113 | 3,877 |
| Increase ... ... | ... ... | 537 | ... ... | 201 | ... ... | 6,731 | 4,007 | 6,000 | ... ... | ... ... | ... ... | ... ... | ... ... |
| Decrease ... ... | ... .. | ... ... | 557 | ... ... | ... ... | ... ... | ... ... | ... ... | ... ... | ... ... | ... ... | 2,501 | 2,085 |

* Publication of receipts temporarily suspended. a Four weeks.